CASSETTE AND APPARATUS FOR LIQUID FREEZING

Background of the invention

The present invention generally relates to freezing a liquid, particularly blood plasma, in a liquid receptacle. More precisely, the invention relates to a cassette and an apparatus for such a treatment for a relatively large liquid volume, i.e. using a relatively large number of liquid receptacles.

It is known from experience that blood plasma should be frozen as soon as possible after the drawing of the blood and the separation of the blood plasma. More precisely, at most two hours should elapse from the drawing to the start of freezing. The freezing process itself should occur quickly enough for the plasma to reach a temperature of about -30°C within an hour. After freezing, the plasma is normally stored at a temperature of about -30°C while awaiting transportation to, for example, a processing facility.

Earlier known examples of liquid receptacles for plasma are plastic bags or essentially parallelepipedal plastic receptacles, so called vials, in which the plasma is kept during handling from the drawing location to the processing location.

It is also earlier known how to use different forms of cooling liquid baths, cooling metal blocks having cavities corresponding to the liquid receptacles and cooling air of high speed for freezing the known liquid receptacles. Cooling with air jets is described in more detail in the international patent application WO97/30317.

Most of the known methods for freezing plasma are designed for relatively small plasma quantities, i.e. for a relatively small number of receptacles, and are not suited for enlargement to higher liquid volumes and a consequential higher number of receptacles, as the manual handling of the receptacles would be time-consuming. Reducing the number of receptacles by increasing the volume of each receptacle is not practically possible or even desirable when it comes to blood plasma as the traceability is or may become a demand, which of course means that a blend of blood plasma from for instance different donors cannot be accepted, or in some cases only to a limited extent.

However, EP 0732097 discloses the use of a cassette and a freezing tun-

nel. This cassette has a frame carrying three perforated and fixed plates above each other for supporting a plurality of plasma bags. A pressure plate and a spring device are provided above each fixed plate in order to press the plasma bags against the fixed plate. Obviously, this approach is lacking in productivity as the loading and the unloading are circumstantial and the packing density of the plasma bags is low.

Summary of the invention

The main object of the present invention is therefore to provide an easy and effective way of handling a relatively large number of liquid receptacles from filling through freezing and to low temperature storage.

According to the invention, this object is obtained by means of a cassette having the new features defined in claim 1. Preferred embodiments of the cassette are defined in claims 2-4.

These features enable: that in a first step a number of liquid receptacles are placed in a layer on a bottom plate; that in a second step an intermediate plate is placed on the previous placed layer of liquid receptacles; that in a third step a further number of the liquid receptacles are placed in a layer on the previously placed intermediate plate; that the second and third steps are repeated a predetermined number of times; and that the plates and the liquid receptacles together are pushed into a freezing tunnel with a streaming cooling medium and are kept in the freezing tunnel until the liquid in all liquid receptacles are frozen. Further, since the cassette has two opposite side walls, which are rigidly connected to the bottom plate for constituting a U-form, each intermediate plate when placed on a layer of liquid receptacles will be fixed laterally in relation to the side walls.

It is obvious that the special plates used make it easy to arrange a batch with a great number of liquid receptacles separate from the freezer tunnel itself and that this batch easily can be pushed into the freezer tunnel and after freezing as easy be taken out from the freezer tunnel. This handling also means that the liquid receptacles at any time may be identified very easily, for example by pointing a bar code reader towards bar codes being fixed on the liquid receptacles when filling the liquid. If the bar code reader is used to register the read data, as

well as the time and the identity of the individual using the bar code reader, in a suitable register, the whole treatment process will be traceable for each separate liquid receptacle.

Thus, the cassette has a bottom plate to support a number of liquid receptacles in one layer, and a number of intermediate plates with substantially the same dimensions as the bottom plate to be placed on each layer of the liquid receptacles and each supporting a further layer of liquid receptacles.

Preferably, each intermediate plate has means cooperating with the side walls so that each intermediate plate when placed on a layer of liquid receptacles will be fixed lengthwise relative the side walls.

The liquid receptacles are preferably flexible and each intermediate plate has spacer means to fix the distance to the subjacent intermediate plate and the bottom plate, respectively.

Further the bottom plate and each intermediate plate have a number of full length ducts which extend in the plane thereof for admitting the cooling medium to flow through them and thereby cool the bottom plate and the intermediate plates when the cassette is in the freezing tunnel.

According to the invention a freezer is further provided having the features that are stated in claim 5. Preferred embodiments of the freezer are defined in claims 6-10.

The freezer has thus a cassette, which contains a bottom plate to support a number of liquid receptacles in a layer and a number of intermediate plates having substantially the same dimensions as the bottom plate to be placed on each layer of liquid receptacles and supporting a further layer of liquid receptacles; a cassette holder, which includes a frame to support the cassette and a number of intermediate plates separated from the cassette; and a freezer tunnel for a streaming cooling medium in which freezing tunnel a cassette with liquid receptacles is inserted from the cassette holder to be kept therein until the liquid in all the liquid receptacles in the cassette is frozen.

The cassette holder of the freezer preferably has a stand for placing the intermediate plates leaning, in contact with each other and successively displaced in height.

The cassette holder can further be mobile for movement from a station for

loading the cassette with the liquid receptacles and the intermediate plates to the freezing tunnel for inserting the loaded cassette therein.

The cassette holder can preferably be made mobile by providing wheels on the frame of the cassette holder.

As cooling medium, preferably air is used in the freezing tunnel, but also other gaseous cooling media are possible.

Brief descriptions of the drawings

Preferred embodiments of the cassette and the freezer according to the present invention will be described in the following with reference to the accompanying drawings, in which:

Fig. 1 is a schematic diagram and shows an embodiment of a freezing tunnel in a freezer according to the invention;

Fig. 2 is a perspective of a first embodiment of a cassette holder and a cassette, which is a part of the freezer according to the invention;

Fig. 3 is a plan view of the cassette holder and the cassette in Fig. 2 after being loaded with a number of liquid receptacles;

Fig. 4 is a cross section view along the line IV-IV in Fig. 3;

Fig. 5 shows in larger scale a partial cross section of one of the intermediate plates in the cassette in Figs. 2-4;

Fig. 6 is a side view of a second embodiment of a cassette holder according to the present invention; and

Fig. 7 is a back view of the cassette holder of Fig. 6.

Detailed description of the preferred embodiments

Referring to Fig. 1, an embodiment of a freezer includes a housing 1, which has a closed circulation channel 2. In this channel 2 a fan 3 is provided in series with a cooling battery 4 and a freezing tunnel 5. A cassette 6, shown in Figs. 2-4, can be introduced into the freezing tunnel 5 via an opening in the housing 1, which can be closed by a lid 7.

In operation, the fan 3 circulates the air in the circulation channel 2 and thus through the cooling battery 4, where the air is cooled, and the freezing tunnel 5, in which the air has a suitable temperature for freezing.

The cooling battery 4 is via conduits 8 and 9 connected to a conventional cooling unit 10 and can for instance be an evaporator for its cooling medium. Alternatively, the cooling unit 10 may be integrated in the housing 1.

Fig. 2 shows the cassette 6 and a cassette holder 11 according to a first embodiment. The cassette 6 itself has a U-form structure with a bottom plate 12 and two opposite side walls 13 and 14 rigidly connected to the bottom plate 12. A number of rectangular intermediate plates 15 of about the same measures as the bottom plate 12 also belong to the cassette 6. Each intermediate plate 15 can then be put over the bottom plate 12 between the side walls 13, 14 and be fixed in its position laterally in relation thereto. Each intermediate plate 15 has two opposite projections 16 (shown in Fig. 5) at two adjacent corners. On each intermediate plate 15, these projections 16 form means, which can cooperate with recesses 17 in the vertical edges of the side walls 13, 14 for fixing the position of the intermediate plate 15 lengthwise in relation to the side walls 13, 14.

The cassette holder 11 in Fig. 2 has a support 18 for the cassette 6 and two parallel and recessed guide walls 19, 20 at the same distance from each other as the side walls 13, 14 of the cassette. A cassette 6 is shown placed on the support 18 with the side walls 13, 14 as direct extensions of the guide walls 19, 20. The intermediate plates 15 can then be placed with their projections 16 inserted into their respective recesses 21 in the guide walls 19, 20 which thus together with a cross bar 22 form a stand for a somewhat sloping placement of the intermediate plates 15. In the position shown for cassette 6 in the cassette holder 11 (Figs. 2-4), the recesses 21 connect at one of their ends each to a separate one of the recesses 17, and the other ends of the recesses 21 are displaced in height, so that the intermediate plates 15, in the sloped placement in the stand, also are displaced in height and in contact with each other.

The support 18 and the recessed guide walls 19, 20 of the cassette holder 11 form the upper part of a frame 23 of the same height as the opening in the freezing tunnel 5. The frame 23 is mobile on wheels 24, which means that the cassette 6 easily can be moved from the cassette holder 11 into the freezing tunnel 5 of the freezer, and vice versa.

Figs. 2-4 also illustrate how the loading of the cassette 6 with flexible liquid receptacles 25 is made.

In a first step, a number of liquid receptacles 25 are placed in a layer on the bottom plate 12.

In a second step, the intermediate plate 15 positioned next to the cassette 6 is lifted, guided by its projections 16 in the recesses 21, and is moved in between the side walls 13, 14 where it is placed on the previously placed layer of liquid receptacles 25, with its projections 16 inserted each into a separate one of the recesses17. The position of each intermediate plate 15 position transversely in relation to the bottom plate 12 is thus controlled by the side walls 13, 14. Further, the position of the intermediate plate 15 lengthwise over the bottom plate 12 is controlled by the engagement of the projections 16 with the recesses 17. Finally, the position of the intermediate plate 15 in height over the bottom plate 12 is controlled partly by the engagement of the projections 16 with the recesses 17, and partly by spacer means in form of two posts 26 at the opposite corners to the projections 16. Each intermediate plate 15 has further a handle 27, which is positioned between the posts 26.

In a third step, a number of liquid receptacles 25 are placed in a layer on the intermediate plate 15 placed on the liquid receptacles in the second step.

Thereafter, the second and third steps are repeated in a predetermined number of times, i.e. from zero to so many times as there are available intermediate plates 15. Finally, an intermediate plate 15 can be placed on the top layer of the liquid receptacles 25.

As can be seen from Fig. 5, each intermediate plate 15 has a number of full length ducts, which extend in the plane of the intermediate plate 15, to admit the cooling medium to flow through them and thereby cool the intermediate plate 15, when the cassette 6 is in the freezing tunnel 5. The projections 16 are provided each on a separate U-profile which is closely connected to a longitudinal edge of the intermediate plate 15.

Preferably, the bottom plate 12 also has similar full length ducts. The intermediate plate 15 is, as the bottom plate 12, preferably made of a light and good heat-transferring material, for instance aluminum or any other light metal or light metal alloy.

As indicated in Fig. 2, the intermediate plate 15 can along its side edge with the handle 27 have a number of openings 28, more precisely one such open-

ing 28 for each liquid receptacle 25, which is intended to be placed on the intermediate plate 15. The equivalent is also valid for the bottom plate 12. These openings 28 are designed for placing test-tubes, which in some cases are annexed each to a separate liquid receptacle 25. Each test-tube contains the same blood plasma as the liquid receptacle to which it is annexed and should be placed in a vertical position during freezing. Since the height of the test-tubes may be greater then the height of the posts 26 defining the spacing between the intermediate plates 15, the test-tubes may be placed in openings alternating between the left and the right half side of the intermediate plates 15, as illustrated in Fig. 2

In order to obtain a good heat transfer between the intermediate plates 15 and the liquid receptacles 25, the latter preferably are so flexible as to make contact with the intermediate plates 15 over as large area as possible.

It is obvious that the invention implies that a cassette 6 can be loaded with liquid receptacles 25 in a simple and ergonomic way, separated from the freezing tunnel 5 itself, for example at a specially for this purpose provided production station. Further, the fully loaded cassette 6 can easily be moved on the cassette holder 11 to the freezing tunnel 5 where it could be docked in order to easily be pushed into this and, after completed freezing of the liquid in the liquid receptacle 25, as easily be taken out from the freezing tunnel 5 and be placed on the cassette holder 11, which later easily can be moved to a space, where the frozen liquid receptacles 25 are transferred to package for storing or to transport package for transfer to another place, which is provided for further storage of the liquid receptacles. Here, the liquid receptacles 25 with the frozen liquid are easily removed from the cassette 6 by raising the intermediate plates 15 one by one and then pushing each one into its sloped position in the stand 22-24 of the cassette holder 11.

For the displacement of cassette 6 in relation to the cassette holder 11, this later has a number of rolls 29, on which the cassette 6 is placed. Further, there is a coupling mechanism (not shown) that can keep the cassette 6 in a desired fixed position on the cassette holder 11 and also release the cassette 6 so that it can be pushed on the rolls 29.

A second embodiment of a cassette holder 30 is illustrated in Figs. 6 and 7 as including a lifting equipment 31 for raising and lowering the cassette 6 on the

cassette holder 30 such that the intermediate plates 15 may be positioned at substantially the same height in their stand 32 on the cassette holder 30.

The lifting equipment 31 illustrated comprises a tresor 33 positioned between an upper plate 34 for carrying the cassette 6 and a lower fixed surface 35. An electric motor 36 is provided for driving an elevating screw 37 to raise or lower the upper plate 34 in accordance with instructions received from a control box 38. During these movements the tresor 33 keeps the upper plate 34 horizontal and parallel to the lower fixed surface 35.

The stand 32 has two guide walls 39, 40, a bottom plate 41 and a back plate 42. The two guide walls 39, 40 correspond to the guide walls 19, 20 illustrated in Figs. 2-4 but have no recesses 21 for the projections 26 of the intermediate plates 15, since such recesses are unnecessary as the height position of the cassette 6 is adjusted by the lifting equipment. The bottom plate 41 may be horizontal or slightly slanting backwards from the cassette 6. The back plate 42 may be substantially vertical or slightly sloping backwards.

When starting the loading of a cassette 6 the lifting equipment 31 holds the cassette 6 in an uppermost position. The lifting equipment 31 then lowers the cassette 6 stepwise for each intermediate plate 15 that is to be placed on the liquid receptacles 25 between the side walls 13, 14 of the cassette 6. When unloading the liquid receptacles 25 with frozen liquid from the cassette 6, the lifting equipment 31 first holds the cassette 6 in a lowermost position and then raises the cassette 6 stepwise for each intermediate plate 15 that is raised from the cassette 6 and placed in the stand 32.

Consequently, the loading and unloading operations are extremely ergonomic as the liquid receptacles 25 are being handled at substantially the same height all the time.

It will be understand that various changes and amendments of the above described embodiment may be made by those skilled in the art within the scope of the invention as expressed in the appended claims.

In one modification, the stand of the cassette holder 11 for placing of the intermediate plates 15 may be released from the frame 23 of the cassette holder, which means that the stand does not have to follow the cassette 6, when this is moved on the cassette holder 11 from a production station to the freezing tunnel

5. The stand could also be more or less permanently fixed to the production station.

Finally, the invention is well suited for freezing other liquids, although it is primarily meant for freezing blood plasma.